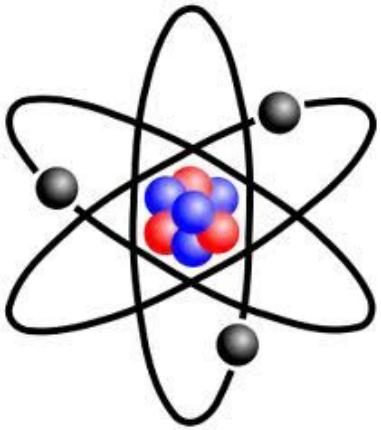


Chemistry I

Atoms

Atomism

- Somewhere about 400 B.C., two Greek philosophers came up with the idea of the atom.
- The two Greeks were Leuicppus of Miletus and Democritus of Abdera (known here after as the two dead Greek dudes).

Atomism

- Their theory has five statements:
  1. All matter is made of atoms, which are bits of matter too small to be seen and cannot be broken.
  2. There is empty space between atoms.
  3. Atoms are completely solid (no space within the atom).
  4. Atoms are homogeneous, with no internal structure.
  5. Atoms are different in size, shape, and weight (added by Epicurus later).

Atomism

- Summary:
  - All did not embrace this idea.
    - Aristotle and others wrote against this idea.
    - The early Catholic Church also did not like this theory.
  - So the atom idea disappeared.

Atomic Theory (1804)

- John Dalton (1766-1844): The Father of the Chemical Atomic Theory
  - **1) Elements are made of tiny particles called *atoms*.**

Atomic Theory

- **2) All atoms of a given element are identical, but different from the atoms of any other element.**

Atomic Theory

- **3) Compounds are formed when atoms of different elements combine in fixed rations.**
  - Chemical combination between two or more atoms occurs in simple, numerical ratios (i.e., 1 to 1, 1 to 2; 2 to 3; etc.).
  - This point gives immediate explanation to the *Law of Definite Proportions*.

Atomic Theory

- **4) A chemical reaction involves a rearrangement of atoms, not a change in the atoms themselves.**

Law of Definite Proportions

- This law is sometimes called the *Law of Constant Composition*.
  - A given chemical compound always contains the same proportion by mass of its constituent elements.
  - A different way to say it:
    - The relative amount of each element in a particular compound is always the same, regardless of where it came from.

Law of Multiple Proportions

- Dalton discovered this law while studying some of the oxides of nitrogen. (sure!!!)
- The law, in modern terminology, is:
  - Atoms of the same element can unite in more than one ratio with another element to form more than one compound.

- Examples: CO and CO_2 H_2O and H_2O_2

Atoms

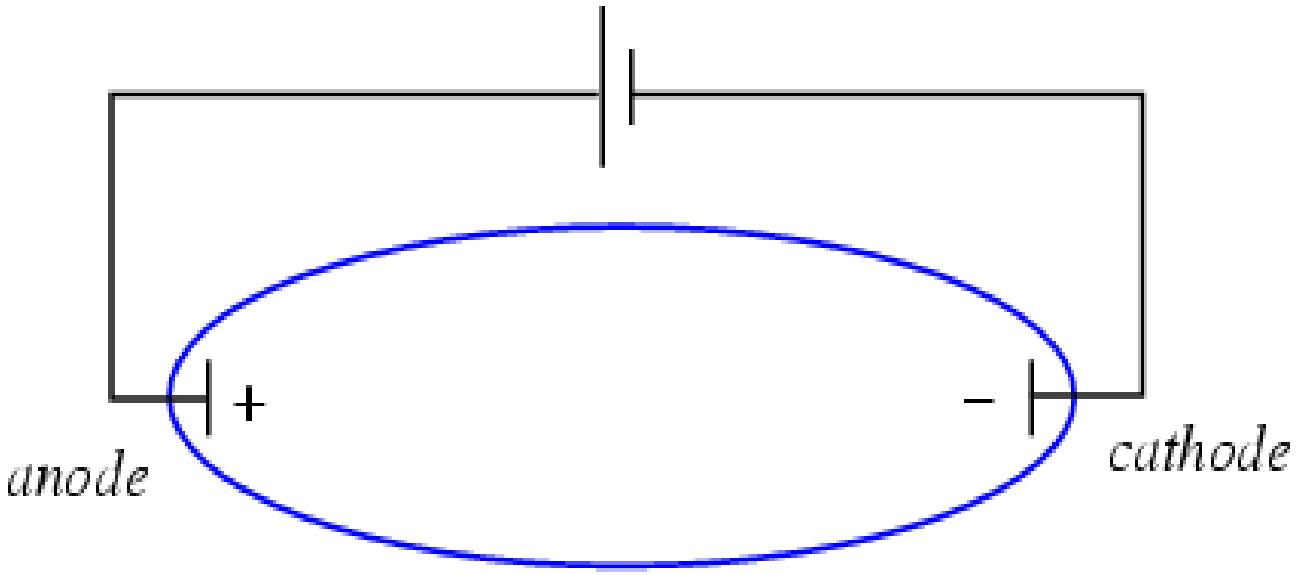
- As it turns out atoms do have parts called subatomic particles.

- In the late 19th century, scientists set out to find out what makes up an atom.

Cathode Rays

- Somewhere about 1880, a guy named Crookes developed a tube w/ metal pieces inside and all of the air sucked out.
- When electricity was applied to the tube a “beam” appeared. The beam traveled from the negative end to the positive end.

Cathode Rays



LOADING...

0

The Electron

- 1897- J.J. Thomson
  - His experiments prompted him to make a bold proposal: these mysterious rays are streams of particles much smaller than atoms, they are in fact minuscule pieces of atoms.
  - The rays are made up of *electrons:* very small, negatively charged particles that are indeed fundamental parts of every atom.

What's the charge??

- Robert Millikan (1868-1953) determined the unit charge of the electron in 1909. This number is -1.

What's up with that?

- If all atoms contain negatively charged electrons, which contribute almost nothing to the mass of the atom, then where is the positive charge needed to make the atom have an overall neutral charge? And the mass?

Nuclear Atom

- 1911- Ernest Rutherford found that the atom has a small dense nucleus at the center. Later determines the nucleus to have a positive charge.

How did they do that??

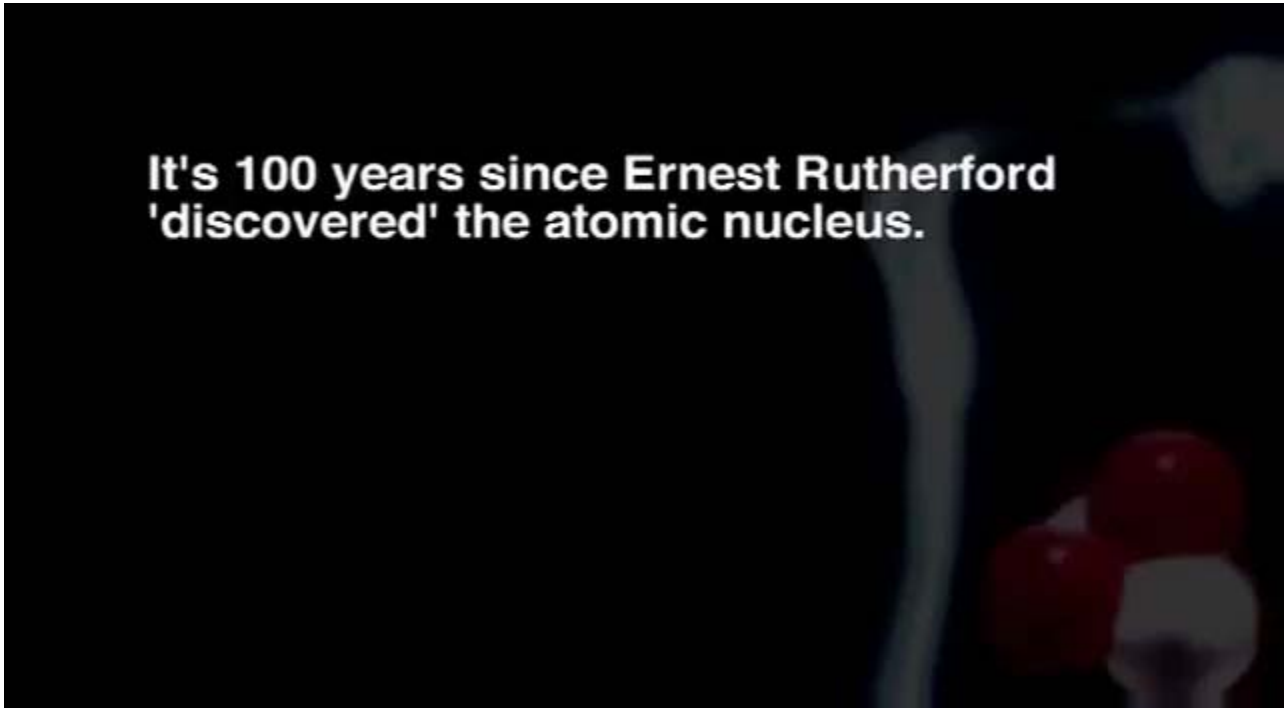
The experiment:

Alpha particles were fired at thin gold foil.

(About 8.6 x 10^{-6} cm)

Alpha particles are helium atoms w/o electrons and have a positive charge

How they do that??



What happened?

- Results:
  - Most of the alpha particles went straight through the gold foil.
  - Some of the alpha particles were deflected.
  - Some like 1 or 2 in several thousand bounced straight back at the source

The conclusions

- Rutherford's conclusions:
  - Atoms are mostly empty space.
  - The center (nucleus) is very dense.
  - The nucleus has a positive charge.

More on the Nucleus.

- **Henry Moseley** (1913-14)
- Calculated the positive charge on the nucleus.
- This is the atomic number.

Summary

- There is a positively charged subatomic particle in the center (nucleus) that has mass.

- Summary: in the center of any atom there is a positively charged particle called the proton.

What next??

- Scientist now had two parts of the atom but they could not account for the mass. Rutherford had predicted its existence but had no laboratory proof of its existence.

The neutron

- 1932- James Chadwick discovers the neutron.
  - Bombarded small atoms(Be) with alpha particles and observed “neutral rays” which were particles similar in mass to protons but had no charge.
  - Hence the neutron (1st named in 1921by William Harkins)

Atom Structure

- Atoms are made of protons, neutrons and electrons.
- The protons and neutrons are held together in the nucleus by strong nuclear forces.
- The nucleus is a dense positively charged area at the center of the atom.
- The nucleus contains 99.9 % of the mass of an atom.
- the electrons are somewhere around the outside of the atom in a region called the electron cloud.
- The size of the atom is about $1 X 10^{-13}$

They’re not all the same.

- As knowledge of the atoms and elements grew, it became apparent that not all atoms of a particular element had the same mass.
- Some seemed to be lighter than others and some seemed to be heavier than some.
- They did have the same chemical and physical properties.

They're not all the same

- These atoms of an element with different masses are called *isotope*.
- The difference in masses is due to a differing number of neutrons in the nucleus of the atom.
- See your element list sheet for correct isotopic symbol notation. Ie Ne-22, C-12, C-13

Isotope examples

Isotope	# protons	# neutrons	# electrons
C-12	6	6	6
C-13	6	7	6
C-14	6	8	6
H-1	1	0	1
H-2	1	1	1
H-3	1	2	1

Atomic Rules

- The number of protons in the nucleus of an atom is equal to the **atomic number (Z)**.
- In a *neutral atom*, the number of electrons is equal to the number of protons.
- The **mass number (M)** of an atom is equal to the sum of the number of protons and neutrons in the nucleus.
- The number of neutrons is equal to the difference between the mass number (M) and the atomic number (Z).

The End